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NATIONAL DAM SAFETY PROGRAM. OAKRIDGE ESTATES LAKE DAM (MO 1103--ETC(U)
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UPPER MISSISSIPPI - SALT - QUINCY BASIN

OAKRIDGE ESTATES LAKE DAM

ST. CHARLES COUNTY, MISSOURI

MO 11033

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

AUGUST 1980

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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UPPER MISSISSIPPI - SALT - QUINCY BASIN

OAKRIDGE ESTATES LAKE DAM

ST. CHARLES COUNTY, MISSOURI

MO 11033

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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Oakridge Estates Lake Dam (MO 11033).
Upper Mississippi - Salt - Quincy Basin.
St. Charles County, Missouri. Phase I
Inspection Report.

United States Army
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St. Louis District

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10 Ralph E. /Sauthofi Albert B. /Becker, Jr

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PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO
ATTENTION OF

LMSED-P

SUBJECT: Oakridge Estates Lake Dam, MO 11033, Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Oakridge Estates Lake Dam, MO 11033:

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

2) Overtopping of the dam could result in failure of the dam.

3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: ______________________________ ____________________
Chief, Engineering Division Date

APPROVED BY: ______________________________ ____________________
Colonel, CE, District Engineer Date

OAKRIDGE ESTATES LAKE DAM

MISSOURI INVENTORY NO. 11033

ST. CHARLES COUNTY, MISSOURI

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

HORNER & SHIFRIN, INC.
5200 OAKLAND AVENUE
ST. LOUIS, MISSOURI 63110

FOR:

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS

AUGUST 1980

HS-8011

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Oakridge Estates Lake Dam
State Located:	Missouri
County Located:	St. Charles
Stream:	Tributary of Dardenne Creek
Date of Inspection:	24 April 1980

The Oakridge Estates Lake Dam was visually inspected by engineering personnel of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of this inspection was to assess the general condition of the dam with respect to safety and, based upon this inspection and available data, determine if the dam poses a hazard to human life or property.

The following summarizes the findings of the visual inspection and the results of certain hydrologic/hydraulic investigations performed under the direction of the inspection team. Based on the visual inspection and the results of these hydrologic/hydraulic investigations, the present general condition of the dam is considered to be somewhat less than satisfactory. The following deficiencies were noticed during the inspection and are considered to have an adverse effect on the overall safety and future operation of the dam:

1. A heavy growth of brush and small-to-medium sized trees were present on the downstream face of the dam. A tree and some brush were also found near the waterline on the upstream face of the dam. Tree roots can provide a passageway for lake seepage which could lead to a piping condition (progressive internal erosion) resulting in

failure of the dam. Brush may conceal animal burrows which could also provide passageways for lake seepage.

2. Several animal burrows were visible within the upstream face of the dam. Animal burrows can provide passageways for lake seepage that could result in a piping condition.

3. Erosion, presumably by wave action, has created a near vertical bank which varies from about 12 inches to approximately 30 inches in height along the upstream face of the dam. Loss of section by erosion can impair the structural stability of the dam.

4. Scouring, apparently by high velocity pipe discharges, has created a pool of water at the downstream end of the spillway outlet pipe adjacent to the toe of the dam. Saturation of the soil adjacent to the dam by standing water can weaken the strength of the material and reduce its capacity to support the dam. Loss of material at the toe of the dam can also impair the stability of the embankment.

According to the criteria set forth in the recommended guidelines, the magnitude of the spillway design flood for the Oakridge Estates Lake Dam, which is classified as small in size and of high hazard potential, is specified to be a minimum of one-half the Probable Maximum Flood (PMF). Considering the fact that numerous dwellings lie within the possible flood damage zone, it is recommended that the spillway for this dam be designed for the PMF. The Probable Maximum Flood (PMF) is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The PMF is ordinarily accepted as the inflow design flood for dams where failure of the structure would increase the danger to human life.

Results of a hydrologic/hydraulic analysis indicated that both spillways, principal plus emergency are inadequate to pass lake outflow resulting from a storm of PMF magnitude. The spillways are capable of passing lake outflow resulting from the one percent chance (100-year frequency) flood and the outflow corresponding to about 25 percent of the PMF. According to the St. Louis District, Corps of Engineers, the length of the downstream damage zone, should failure of the dam occur, is estimated to be two miles. Accordingly, within the possible damage zone are approximately twenty-two dwellings.

A review of available data did not disclose that seepage or stability analyses of the dam were performed. This is considered a deficiency and should be rectified.

It is recommended that the Owner take the necessary action to correct or control the deficiencies and safety defects reported herein without undue delay.

Ralph E. Sauthoff

Ralph E. Sauthoff
P. E. Missouri E-19090

Albert B. Becker, Jr.

Albert B. Becker, Jr.
P. E. Missouri E-9168

OV[illegible] ESTATES LAKE DAM

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

OAKRIDGE ESTATES LAKE DAM - MO 11033

TABLE OF CONTENTS

Paragraph No.	Title	Page No.
	SECTION 1 - PROJECT INFORMATION	
1.1	General	1-1
1.2	Description of Project	1-1
1.3	Pertinent Data	1-3
	SECTION 2 - ENGINEERING DATA	
2.1	Design	2-1
2.2	Construction	2-1
2.3	Operation	2-1
2.4	Evaluation	2-2
	SECTION 3 - VISUAL INSPECTION	
3.1	Findings	3-1
3.2	Evaluation	3-4
	SECTION 4 - OPERATIONAL PROCEDURES	
4.1	Procedures	4-1
4.2	Maintenance of Dam	4-1
4.3	Maintenance of Outlet Operating Facilities	4-1
4.4	Description of Any Warning Systems in Effect	4-1
4.5	Evaluation	4-1

Paragraph No.	Title	Page No.
	SECTION 5 - HYDRAULIC/HYDROLOGIC	
5.1	Evaluation of Features	5-1
	SECTION 6- STRUCTURAL STABILITY	
6.1	Evaluation of Structural Stability	6-1
	SECTION 7 - ASSESSEMENT/REMEDIAL MEASURES	
7.1	Dam Assessment	7-1
7.2	Remedial Measures	7-2

LIST OF PLATES

Plate No.	Title
1	Regional Vicinity Map
2	Oakridge Estates Lake Location Plan
3	Lake Watershed Map
4	Dam Plan and Profile
5	Dam Section
6	Emergency Spillway Cross-Section

APPENDIX A - INSPECTION PHOTOGRAPHS

Page No.	Title
A-1 thru A-4	Inspection Photographs

APPENDIX B - HYDROLOGIC AND HYDRAULIC ANALYSES

Page No.	Title
B-1 thru B-3	Hydrologic & Hydraulic Computations
B-4 thru B-6	Computer Input Data
B-7 thru B-10	Computer Output Data
B-11	Lake Surface Area, Elevation and Storage Volume: Summary Dam Safety Analyses

PHASE I INSEPCTION REPORT

NATIONAL DAM SAFETY PROGRAM

OAKRIDGE ESTATES LAKE DAM - MO 11033

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, dated 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, directed that a safety inspection of the Oakridge Estates Lake Dam be made.

b. Purpose of Inspection. The purpose of this visual inspection was to make an assessment of the general condition of the above dam with respect to safety and, based upon available data and this inspection, determine if the dam poses a hazard to human life or property.

c. Evaluation Criteria. This evaluation was performed in accordance with the "Phase I" investigation procedures as prescribed in "Recommended Guidelines for Safety Inspection of Dams," Appendix D to "Report to the Chief of Engineers on the National Program of Inspection of Non-Federal Dams," dated May 1975.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances. The Oakridge Estates Lake Dam is an earthfill type embankment rising approximately 27 feet above the original streambed. The embankment has an upstream slope (above the waterline) of 1v on 2.6h, a crest width of about 17 feet, and a downstream slope of 1v on 2.1h. A road surfaced with crushed stone for access to private property south of the dam, traverses the dam crest. The length of the dam is approximately 550 feet. A plan and profile of the dam are shown on Plate 4 and a cross-section of the dam is shown on Plate 5.

The dam has both a principal and an emergency spillway. The principal spillway, a 12-inch diameter steel pipe that passes through the embankment, is located just to the left of the center of the dam; the pipe has an antivortex plate attached to the upstream end. A trash rack constructed of reinforcing bars surrounds the inlet end of the pipe to protect the spillway from clogging. The spillway outlet discharges to the original stream channel at the toe of the dam.

The emergency spillway is located at the right or south abutment. The spillway crest, an earthen V-shaped section, is constructed as a low area in the crest of the earth fill dam. The spillway outlet follows the downstream slope of the embankment to its toe, then crosses a relatively flat area to join the original stream beyond the toe of the dam. A 12-inch diameter corrugated metal pipe culvert which is lower in elevation than the emergency spillway crest passes beneath the roadway near the right abutment. Flow from the culvert joins the emergency spillway outlet channel. A cross-section of the emergency spillway is shown on Plate 6.

b. Location. The dam is located within the Oakridge Estates Subdivision on an unnamed tributary of Dardenne Creek, about 1/4 mile south of Mexico Road and 2 miles west of St. Peters, Missouri, as shown on the Regional Vicinity Map, Plate 1. The relative location of the lake within the Oakridge Estates Subdivision is shown on the Lake Location Plan, Plate 2. The dam is located in Section 34, Township 47 North, Range 3 East, within St. Charles County.

c. Size Classification. The size classification based on the height of the dam and its storage capacity, is categorized as small. (Per Table 1, Recommended Guidelines for Safety Inspection of Dams.)

d. Hazard Classification. Oakridge Estates Lake Dam, according to the St. Louis District, Corps of Engineers, has a high hazard potential, meaning that if the dam should fail, there may be loss of life, serious damage to homes, or extensive damage to agricultural, industrial and commercial facilities, important public utilities, main highways, or railroads. The estimated flood damage zone, should failure occur, as determined by the St. Louis District, extends two miles downstream of the dam. Within the possible damage zone are approximately twenty-two dwellings. Those features lying within the downstream damage zone reported by the Corps of Engineers, St. Louis District, were verified by the inspection team.

e. Ownership. The lake and dam are located on common ground within the Oakridge Estates Subdivision which is owned by the HFS Corporation, 12680 Olive Street Road, St. Louis, Missouri 63141. HFS Corporation, the developers of Oakridge Estates, is a service corporation of Home Federal Savings and Loan Association. Mr. Ralph Fassel is president of the Home Federal Savings and Loan Association.

f. Purpose of Dam. The dam impounds water for recreational use by residents of Oakridge Estates.

g. Design and Construction History. According to Mr. Andrew Stiert, the original dam owner, the dam was constructed in about 1964 by Tegethoff Excavating Co., of St. Charles, Missouri. Mr. Stiert also reported that engineering assistance for the design and construction of the dam was provided by the U.S. Department of Agriculture Soil Conservation Service (SCS). According to Mr. Les Volmert, District Conservationist, Soil Conservation Service, SCS did provide technical assistance, however, records of the design are no longer available. The extent of the engineering investigations performed for design of the dam are unknown.

h. Normal Operational Procedure. The lake level is unregulated. Lake outflow is governed by the capacities of the principal spillway, a 12-inch diameter pipe, and the overflow type emergency spillway.

1.3 PERTINENT DATA

a. Drainage Area. Portions of two residential type subdivisions occupy more than one-half of the watershed. The remainder of the watershed is farmland except for a relatively small area which is wooded. The watershed above the dam amounts to approximately 211 acres. The watershed area is outlined on Plate 3.

b. Discharge at Damsite.

(1) Estimated known maximum flood at damsite... 6 cfs* (W.S. Elev. 519.0)

(2) Spillway capacity

a. Principal ... 9 cfs (W.S. Elev. 521.0)

b. Principal + Emergency ... 420 cfs (W.S. Elev. 522.9)

c. Elevation (Ft. above MSL). The following elevations were determined by survey and are based on topographic data shown on the 1954 O'Fallon, MO Quadrangle Map, 7.5 Minute Series, photo revised 1974.

(1) Observed pool ... 517.1

(2) Normal pool ... 517.0

(3) Spillway Crest

a. Principal ... 517.0

b. Emergency ... 521.0

(4) Maximum experienced pool ... 521.1**

(5) Top of Dam ... 522.9 (min.): 524.9 (max.)

(6) Streambed at centerline of dam ... 501±

(7) Maximum tailwater ... Unknown

(8) Observed tailwater ... 500.4

d. Reservoir.

(1) Length at normal pool (Elev. 517.0) ... 1,000 ft.

(2) Length at maximum pool (Elev. 522.9) ... 1,900 ft.

* Based on an estimate of the level of the lake relative to the principal spillway as observed by the original owner of the dam.

**Based on an estimate of lake level as observed by Mr. Peluso, a resident living adjacent to the lake. The maximum lake elevation occurred in 1979 when the principal spillway was clogged.

e. Storage.

(1) Normal pool ... 33 ac. ft.

(2) Top of Dam (incremental) ... 80 ac. ft.

f. Reservoir Surface.

(1) Normal pool ... 6 acres

(2) Top of dam (incremental) ... 14 acres

g. Dam. The height of the dam is defined to be the overall vertical distance from the lowest point of foundation surface at the downstream toe of the barrier to the top of the dam.

(1) Type ... Earthfill, homogenous*

(2) Length ... 550 ft.

(3) Height ... 27 ft.

(4) Top width ... 17 ft.

(5) Side slopes

a. Upstream ... 1v on 2.6h (above waterline)

b. Downstream ... 1v on 2.1h

(6) Cutoff ... Clay core*

(7) Slope protection

a. Upstream ... Grass

b. Downstream ... Grass

h. Spillway.

(1) Type ... Uncontrolled, 12-inch diameter steel pipe, hooded

(2) Location ... Sta. 3+22, 28 feet upstream

(3) Crest ... Elevation 517.0

* Per Mr. Tegethoff, dam builder.

i. Emergency Spillway

(1) Type ... Uncontrolled, irregular V-shaped earth section

(2) Location ... Right abutment

(3) Crest ... Elevation 521.0

(4) Approach Channel ... Lake

(5) Exit Channel ... Unconfined, earth section

j. Lake Drawdown Facility . . . None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

According to Mr. Les Volmert, District Conservationist for the U.S. Department of Agriculture, Soil Conservation Service, technical assistance for design of the dam was provided by the Soil Conservation Service, but records of the design are no longer available.

2.2 CONSTRUCTION

No formal records were maintained during construction of the dam. As previously stated, Oakridge Estates Dam was constructed in about 1964 by the Tegethoff Excavating Company of St. Charles, Missouri. An interview with Mr. Clem H. Tegethoff, owner of Tegethoff Excavating Company at the time the dam was built, indicated that a core trench approximately 12 feet wide was excavated about 8 feet deep to reach what was considered to be a more impervious material. Mr. Tegethoff reported that fill for the dam was obtained from the areas to be occupied by the lake and from the surrounding hillsides and that the fill material was compacted with a sheepsfoot roller. He also mentioned that three 8-foot by 4-foot steel anti-seepage collars were welded to the spillway outlet pipe.

2.3 OPERATION

The lake level is uncontrolled and under normal conditions governed by the elevation of the crest of the principal spillway pipe. An emergency spillway, with a crest elevation approximately 4 feet higher than the crest of the principal spillway and about 1.9 feet lower than the top of the dam at its lowest point, is located at the right abutment. A 12-inch culvert, which is also located near the right abutment, has an invert elevation approximately 3.4 feet higher than that of the principal spillway pipe. No indication was found that the dam has been overtopped. Mr. Andrew Stiert, the previous owner reported that during the time he owned the lake, the dam was not overtopped and that the highest lake level experienced occurred in about 1969 when the surface was approximately 12 inches above the top of the principal spillway pipe. Mr. Victor Peluso, who has resided adjacent to the lake for about four years, also reported that during this 4 year period the dam has not been overtopped. Mr. Peluso reported that the highest lake level he observed occurred in April of 1979 when the depth of flow over the emergency spillway crest was estimated to be about one inch. However at that time, according to Mr. Peluso, the pipe spillway was plugged and could not function properly. It is understood that the trash rack at the upstream end of the pipe spillway was installed shortly thereafter. There have been no reports of pipe spillway blockage since installation of the trash rack, and it appears that the trash rack is adequate for the purpose intended.

2.4 EVALUATION

a. Availability. Engineering data for assessing the design of the dam and spillways were unavailable.

b. Adequacy. No data available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Oakridge Estates Lake Dam was made by Horner & Shifrin engineering personnel, R. E. Sauthoff, Civil Engineer and A. B. Becker, Jr., Civil and Soils Engineer, on 24 April 1980. An examination of the dam site was also made by an engineering geologist, Jerry D. Higgins, Ph.D., a consultant retained by Horner & Shifrin for the purpose of assessing the area geology. Also examined at the time of the inspection, were the areas and features below the dam within the potential flood damage zone. Photographs of the dam taken at the time of the inspection are included on Pages A-1 through A-4 of Appendix A. The locations of the photographs taken during the inspection are indicated on Plate 4.

b. Site Geology. Oakridge Lake is located in an eastward trending valley of a small unnamed tributary to Dardenne Creek. The site is in the uplands approximately three miles south of the Mississippi River flood plain. The area is located near the northern edge of the Ozark Plateaus Physiographic Province, close to the border with the Dissected Till Plains Section of the Central Lowlands Physiographic Province. The topography is gently rolling, but urban development has modified most of the original land surface in the vicinity of the lake. There is about 60 feet of relief between the lake site and the surrounding drainage divides. The bedrock formations consist of gently northward dipping Mississippian-age sedimentary strata. No specific outcrops were noted at the site; however, bedrock exposures in the general vicinity indicate that the area is underlain by the Burlington-Keokuk limestones. No faults were observed or are reported to be present in this area.

The Burlington-Keokuk are light-to-buff colored, coarsely crystalline, medium-bedded limestones. Both formations are fossiliferous and contain abundant chert in the form of layers and nodules. They are highly susceptible to solution weathering. Sinkholes, caves, and solution-enlarged joints or bedding planes are common. The contact between the bedrock and the overlying surficial material is usually irregular, and pinnacles or bedrock remnants frequently occur in the residual material.

The bedrock is overlain by a thick deposit of Harvester Series soils. This series consists of deep, well-drained soils formed from the wind deposited silts on the uplands adjacent to the Missouri River Valley. It is a yellowish brown, friable silt in the upper layers, becoming darker and more clayey with depth. The soils are classified as CL or CL-ML materials, and are relatively permeable and susceptible to erosion, but generally they are suitable for embankments and reservoirs. Glacial till was observed underlying the Harvester soils downstream from the embankment. The till is a dense, blocky, plastic clay, gray to mottled in color. Although it was not observed in the immediate vicinity of the reservoir of embankment, it is very probable that it overlies the bedrock at the lake site.

There appear to be no significant geotechnical problems at the Oakridge Lake site. No adverse geologic conditions were observed that would be conducive to severe reservoir leakage or embankment instability.

c. Dam. The visible portions of the upstream and downstream faces of the dam (see Photos 1 and 2) as well as the dam crest were inspected and, except as noted herein, appeared to be in sound condition. However, the downstream face could not be thoroughly examined due to the presence of a dense growth of brush and small-to-medium size trees on the slope. Erosion of the upstream face of the dam, apparently due to wave action, has created an almost vertical bank which varies from about 12 inches to approximately 30 inches in height at the normal waterline. Several animal burrows (see Photo 8) existed along the upstream face of the dam although brushy growth near the waterline prevented a thorough inspection and even more burrows may exist. A power pole and a small tree were also evident on the upstream face. The portions of the upstream and downstream faces of the dam which were not covered with brush or trees had a relatively thick growth of fescue grass. A road surfaced with crushed stone follows the entire length of the crest of the dam. Sliding or cracking of the dam was not evident in those portions of the embankment which were examined. No cracking, settlement, or misalignment of the dam was noticed. An examination of the surficial material of the dam indicated it to be a silty lean clay (CL) of low-to-medium plasticity.

Minor erosion was evident on the downstream side of the dam in two locations. A channel approximately one foot deep had been eroded in the invert of the emergency spillway near the right abutment. Near the location of the pipe spillway, a footpath which extended from the crest of the dam to the downstream toe was bare of vegetation and showed evidence of minor erosion from stormwater runoff.

There was no evidence of seepage in the areas examined, however, the dense growth of brush and trees on the downstream slope of the dam prevented a thorough inspection. Scour, apparently by high velocity pipe discharges, has created a pool (see Photo 4), approximately 20 feet wide, 30 feet long, and 2 feet deep at the downstream end of the spillway outlet pipe adjacent to the toe of the dam. It could not be determined if seepage was occurring along the spillway pipe or beneath the dam at the pool.

The visible areas of the inlet and outlet ends of the 12-inch steel spillway pipe including the reinforcing bar trash rack, (see Photos 3 and 4) were examined and except for a thin layer of rust due to corrosion of the steel, appeared to be in sound condition. Litter and debris consisting of paper and pieces of wood were evident along the waterline near the inlet end of the pipe. Adjacent to the spillway, the upstream face of the dam was appreciably eroded with a vertical bank about 30 inches high and 6 feet long formed in the face of the dam near the pipe.

The low area in the embankment near the right abutment that serves as the emergency spillway (see Photo 5) as well as the spillway outlet channel just downstream of the crest were, except for the roadway that crosses the crest, well covered with grass and appeared to be well maintained.

The metal end sections of the 12-inch corrugated metal pipe culvert (see Photo 7) that extends through the dam at an elevation slightly lower than the crest of the emergency spillway were partially collapsed leaving a vertical opening of about 7 inches. The upstream end of the culvert was partially filled with debris and leaves.

d. Appurtenant Structures. No appurtenant structures were observed at this dam site.

e. Downstream Channel. The downstream channel, the original stream on which the dam is constructed, is unimproved for a distance of approximately 900 feet at which point flow enters a short section of 54-inch diameter pipe. Flow is conducted within the pipe for approximately 50 feet before rejoining the unimproved channel. About 1,100 feet below the dam flow again enters a section of 54-inch diameter pipe which ends approximately 1,600 feet downstream of the dam and just upstream of the Birdie Hills Road Bridge crossing, the first downstream crossing below the dam. With the exception of the two road crossings at Sunny Side Drive and Harris Drive, the remainder of the channel is unimproved. At Sunny Side Drive, the second downstream crossing, the flow is conducted under the road in two 72-inch diameter steel pipes. The third crossing, which is at Harris Drive consists of two 84-inch diameter steel pipes. Approximately 8,000 feet below the dam, the channel joins Dardenne Creek.

f. Reservoir. The area adjacent to the lake is well maintained with the lake banks and hillside slopes covered with grass and some trees. Surrounding the lake are several residences, tennis courts, and a swimming pool. Some sedimentation was visible at the upstream end of the lake, apparently due to outwash from the cultivated land which lies upstream within the watershed. According to Mr. Peluso who resides adjacent to the upstream end of the lake, material was excavated from the lake bottom near the shoreline at the upper end of the lake in 1979. Freshly excavated material was observed along the shoreline of the north side of the lake near the upstream end. The amount of sediment remaining in the lake could not be determined; however, it is believed to be insignificant.

3.2 EVALUATION

The deficiencies observed during the inspection and noted herein are not considered of significant importance to warrant immediate remedial action. However, it is recommended that, as soon as practical, the trees and brush be removed from the embankment as indicated in paragraph 7.2b(1) and that the entire downstream slope be re-examined after it is cleared for signs of seepage, erosion, and other defects.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The spillways are uncontrolled. The lake surface level is governed by precipitation runoff, evaporation, seepage, and the capacity of the uncontrolled principal and emergency spillways.

4.2 MAINTENANCE OF DAM

Judging by the growth of trees and brush on the downstream face and animal burrows in the upstream face of the dam, the inspection team is of the opinion that maintenance of the dam has been neglected.

4.3 MAINTENANCE OF OUTLET OPERATING FACILITIES

No outlet facilities requiring operation exist at this dam, and there is no reservoir regulation plan.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection did not reveal the existence of a dam failure warning system.

4.5 EVALUATION

Lack of adequate maintenance is considered detrimental to the safety of the dam. It is recommended that maintenance of the dam be undertaken on a regular basis and that records be kept of all major items of work performed. It is also recommended that a detailed inspection of the dam be instituted on a regular basis by an engineer experienced in the design and construction of dams and that records be kept of all inspections made and remedial measures taken.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data are not available.

b. Experience Data. The drainage area and lake surface area were determined from the 1954 USGS O'Fallon, Missouri, Quadrangle Map. The proportions and dimensions of the spillways and dam were developed from surveys made during the inspection. Records of rainfall, streamflow, or flood data for the watershed were not available.

According to the St. Louis District, Corps of Engineers, the estimated flood damage zone, should failure of the dam occur, extends two miles downstream of the dam. At a point approximately 900 feet downstream of the dam, flow leaving the downstream channel is confined within a short section of 54-inch diameter pipe. About 1,100 feet downstream of the dam the flow again enters a section of 54-inch diameter pipe and continues within the pipe for about another 500 feet before rejoining the unimproved channel just upstream of the Birdie Hills Road Bridge crossing.

c. Visual Observations.

(1) The principal spillway consists of a 12-inch diameter steel pipe with an 18-inch square anti-vortex plate above the inlet end of the pipe. Welded reinforcing bars surrounding three sides and the top of the inlet serve as a trash screen. The pipe passes through the embankment near the center of the dam.

(2) The emergency spillway, a shallow broad-crested irregular V-shaped earth section is located near the right (south) abutment.

(3) A 12-inch corrugated metal pipe culvert with metal end sections is located near the right abutment.

(4) The original stream channel abuts the dam.

(5) A rise in the lake level to the elevation of the top of the dam would probably cause flooding of several dwellings located adjacent to the upstream areas of the lake.

d. Overtopping Potential. The spillways (principal plus emergency) are inadequate to pass the probable maximum flood, or 1/2 the probable maximum flood, without overtopping the dam. The results of the dam overtopping analyses are as follows:

(Note: The data appearing in the following table were extracted from the computer output data appearing in Appendix B. Decimal values have been rounded to the nearest one-tenth in order to prevent assumption of unwarranted accuracy.)

Ratio of PMF	Q-Peak Outflow (cfs)	Max. Lake W.S. Elev.	Max. Depth of Flow over Dam (Elev. 522.9)	Duration of Overtopping of Dam (Hours)
0.50	1,284	523.9	1.0	1.8
1.00	2,991	524.8	1.9	5.4

Elevation 522.9 was found to be the lowest point in the dam crest. The flow safely passing the spillway just prior to overtopping was determined to be approximately 420 cfs, which is the routed outflow corresponding to about 25 percent of the probable maximum flood inflow. During peak flow of the probable maximum flood, the greatest depth of flow over the dam is projected to be 1.9 feet and overtopping will extend from the left abutment to approximately 75 feet left of the center of the dam and from about the center of the dam to the right abutment.

e. Evaluation. Experience with embankments constructed of similar material (a silty lean clay of low-to-medium plasticity) to that used to construct this dam have shown evidence that the material under certain conditions, such as high velocity flow, can be very erodible. Such a condition exists during the PMF when large lake outflow, accompanied by high flow velocities, occurs. For the PMF condition where the depth of flow over the dam crest, a maximum of 1.9 feet, and the duration of flow over the dam, 5.4 hours, are considerable, damage by erosion to the crest and downstream face of the dam is expected. The extent of these damages is not predictable;

however, there is a possibility that they could result in failure by erosion of the dam.

f. References. Procedures and data for determining the probable maximum flood, the 100-year frequency flood, and the discharge rating curve for flow passing the spillway and dam crest are presented on Pages B-1 through B-3 of the Appendix. Listings of the HEC-1 (Dam Safety Version) input data for both the probable maximum flood and the 100-year frequency flood are shown on pages B-4 through B-6. Computer output data, including unit hydrograph ordinates, tabulation of PMF rainfall, loss and inflow data are shown on pages B-7 through B-10; tabulation of lake surface area, elevation and storage volume is shown on page B-11 and tabulations titled "Summary of Dam Safety Analysis" for the PMF and 1 percent chance (100-year frequency) flood are also shown on page B-11.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which adversely affect the structural stability of the dam are discussed in Section 3, paragraph 3.1c.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam are known to exist. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Operating Records. No appurtenant structures or facilities requiring operation exist at this dam.

d. Post Construction Changes. With the exception of the addition of the trash rack at the upstream end of the spillway pipe, both the previous owner and Mr. Ralph Fassel, a representative of the present owner, reported that no post construction changes were made or have occured which would affect the structural stability of the dam.

e. Seismic Stability. The dam is located within a Zone II seismic area. An earthquake of this magnitude would not be expected to cause structural damage to a well constructed earth dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. A hydraulic analysis indicated that the spillway is capable of passing lake outflow of about 420 cfs without the level of the lake exceeding the low point in the top of the dam. A hydrologic analysis of the lake watershed area, as discussed in Section 5, paragraph 5.1d, indicated that for storm runoff of probable maximum flood magnitude, the lake outflow would be on the order of 2,991 cfs, and that for the 1 percent chance (100-year frequency) flood, the lake outflow would be about 48 cfs.

Seepage and stability analyses of the dam were not available for review and therefore no judgment could be made with respect to the structural stability of the dam.

Several items were noticed during the visual inspection that could adversely affect the safety of the dam. These items include trees and brush on the dam slopes, animal burrows within the upstream face of the dam, and erosion of the upstream face of the dam as well as the area adjacent to the downstream toe of the dam.

b. Adequacy of Information. Due to lack of design and construction data, the assessments reported herein were based on external conditions as determined during the visual inspection. The assessment of the hydrology of the watershed and capacity of the spillway were based on a hydrologic/hydraulic study as indicated in Section 5. Seepage and stability analsyes comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. The remedial measures recommended in paragraph 7.2 for the items concerning the safety of the dam noted in paragraph 7.1a should be accomplished without undue delay. Provision of additional spillway capacity as recommended in paragraph 7.2a(1) should be pursued on a high priority basis.

d. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II investigation is not recommended.

e. Seismic Stability. The dam is located within a Zone II seismic area. An earthquake of this magnitude would not be expected to cause structural damage to a well constructed earth dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

a. Recommendations. The following actions are recommended:

(1) Based upon criteria set forth in the recommended guidelines, spillway size and/or height of dam should be increased to pass lake outflow resulting from a storm of probable maximum flood magnitude; in either case, the spillway should be protected to prevent erosion.

(2) Obtain the necessary soil data and perform dam seepage and stability analyses in order to determine the structural stability of the dam for all operational conditions. Seepage and stability analyses should be performed by a qualified professional engineer experienced in the design and construction of earthen dams. The presence of the pool at the toe of the dam should be taken into consideration when stability analyses are made or provision should be made to drain the pool and prevent formation by scour of a like condition.

b. Operations and Maintenance (O & M) Procedures. The following O & M Procedures are recommended:

(1) Remove the trees and brush from the dam proper and the areas adjacent to the downstream toe of slope. The removal of trees should be performed under the direction and guidance of an engineer experienced in the design and construction of earthen dams, since indiscriminate clearing can jeopardize the safety of the dam. Once the dam and adjacent downstream area

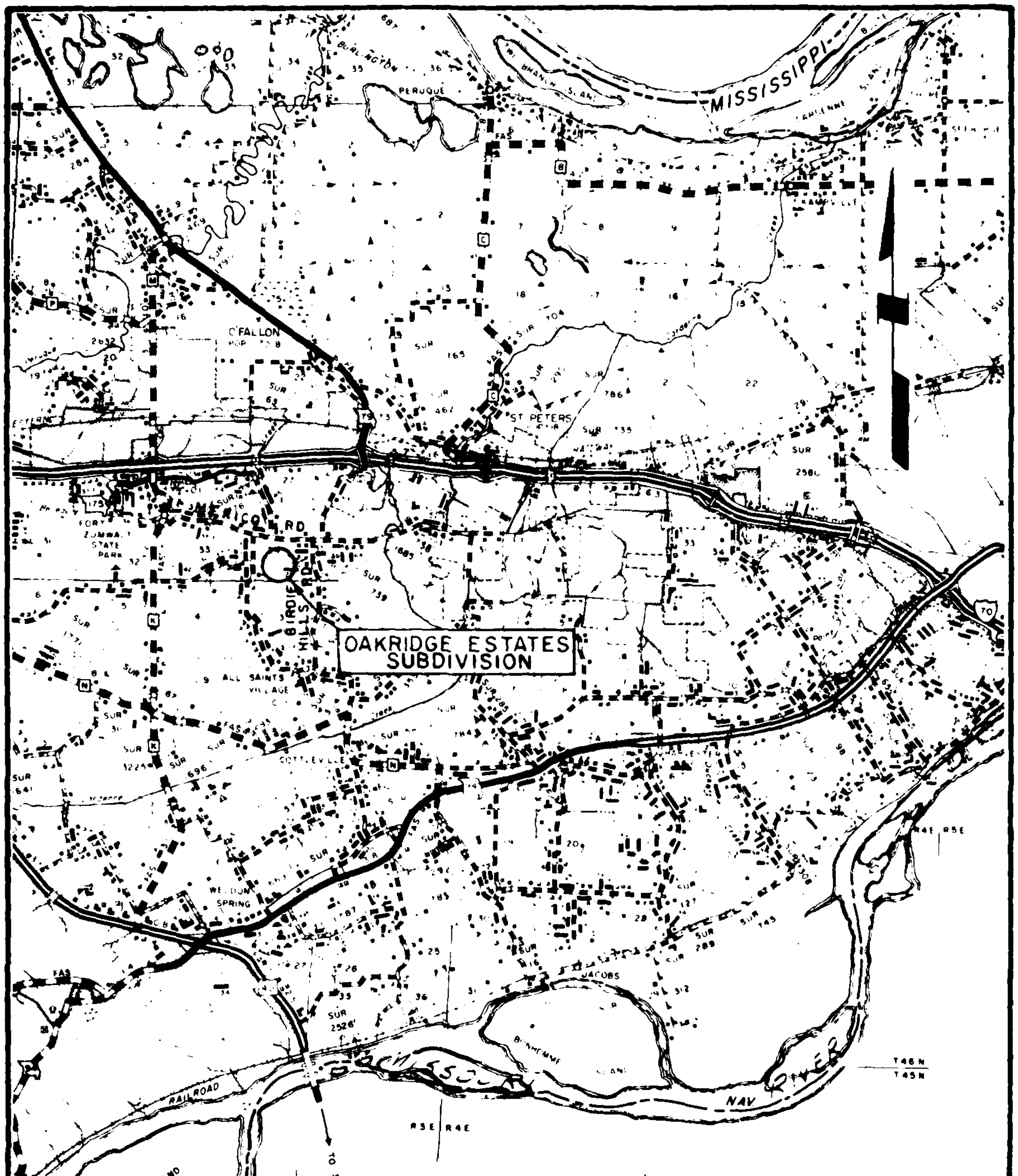
are cleared of trees and brush, they should be thoroughly examined by an engineer for seepage, erosion, sloughing and other signs of instability. The existing turf cover should be restored if destroyed or missing. Maintain the turf cover at a height that will not hinder inspection of the embankment or provide cover for burrowing animals. Holes from trees roots and voids created by burrowing animals can provide a pathway for seepage that could lead to a piping condition (progressive internal erosion) and potential failure of the dam.

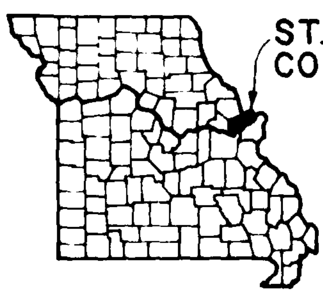
(2) Rid the dam of burrowing animals and restore the embankment to sound condition. As stated above, animal burrows can lead to a piping condition and potential failure of the dam.

(3) Restore the upstream face of the dam and provide some form of protection other than grass at and above the normal waterline in order to prevent erosion. A grass covered slope is not considered adequate protection to prevent erosion by wave action or by a fluctuating lake level.

(4) Provide maintenance of all areas of the dam and spillways on a regularly scheduled basis in order to insure features of being in satisfactory operating condition.

(5) A detailed inspection of the dam should be instituted on a regular basis by an engineer experienced in the design and construction of dams. It is also recommended that records be kept for future reference of all inspections made and remedial measures taken.





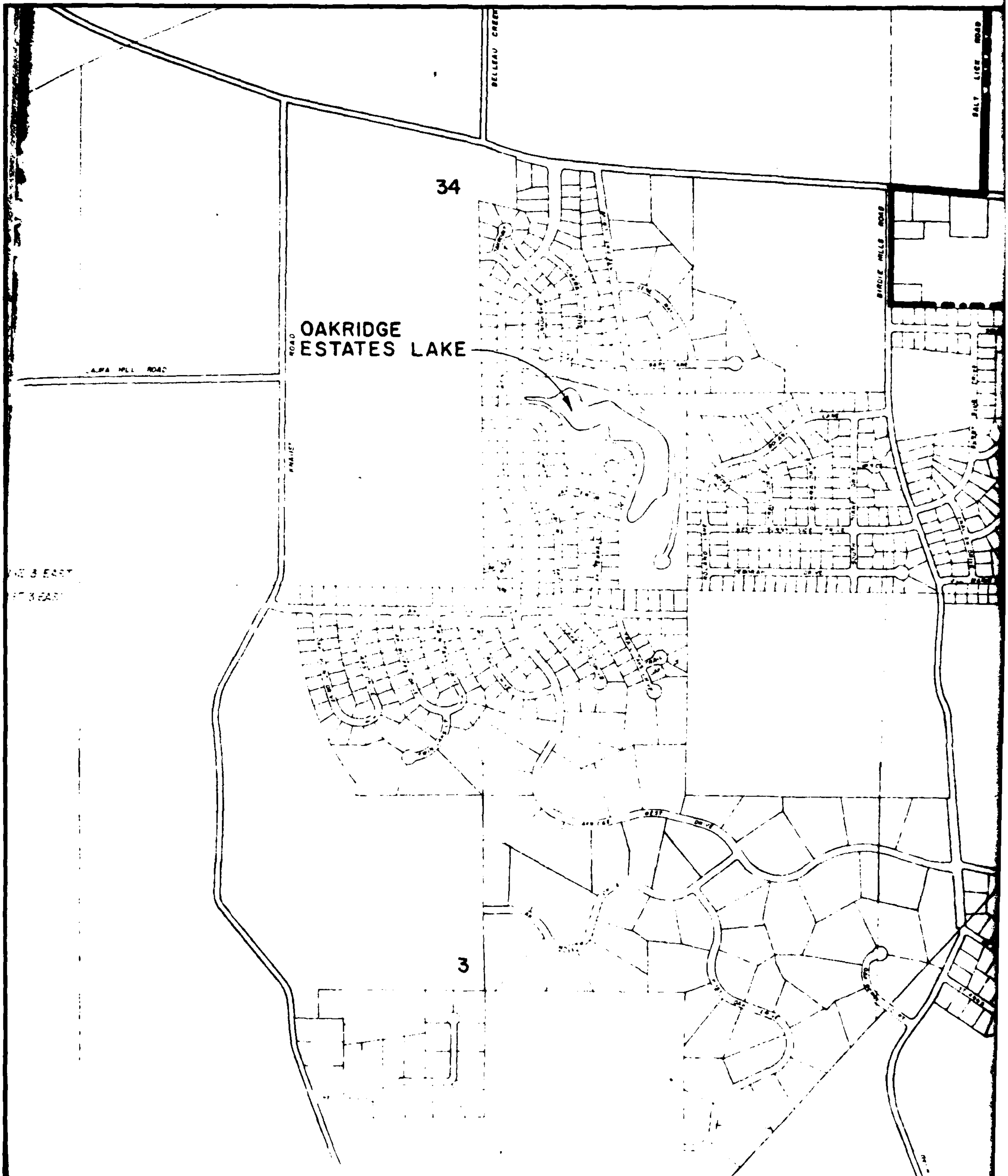
LOCATION MAP

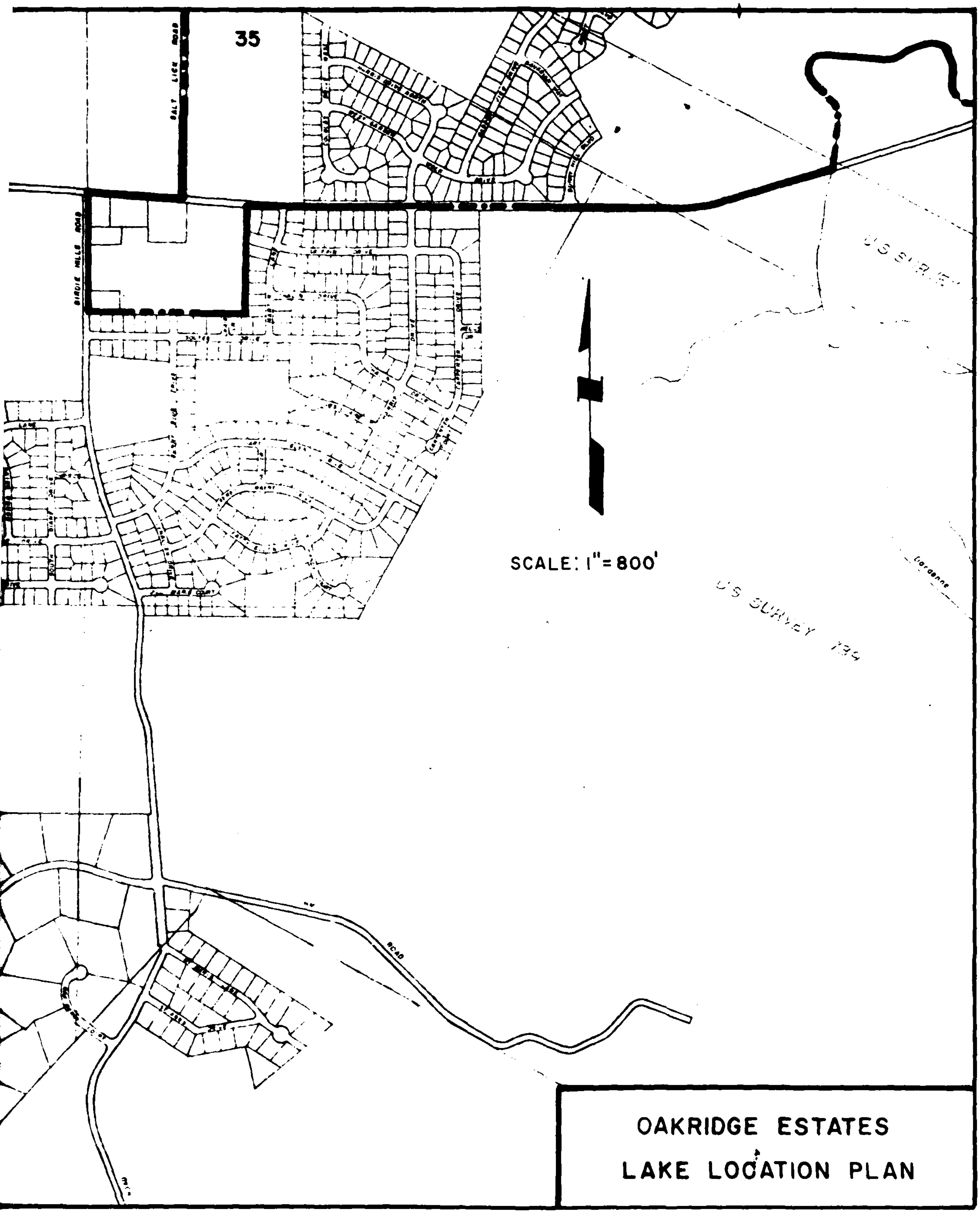
OAKRIDGE ESTATES SUBDIVISION

1 0 1 2 3 4

SCALE (MILES)

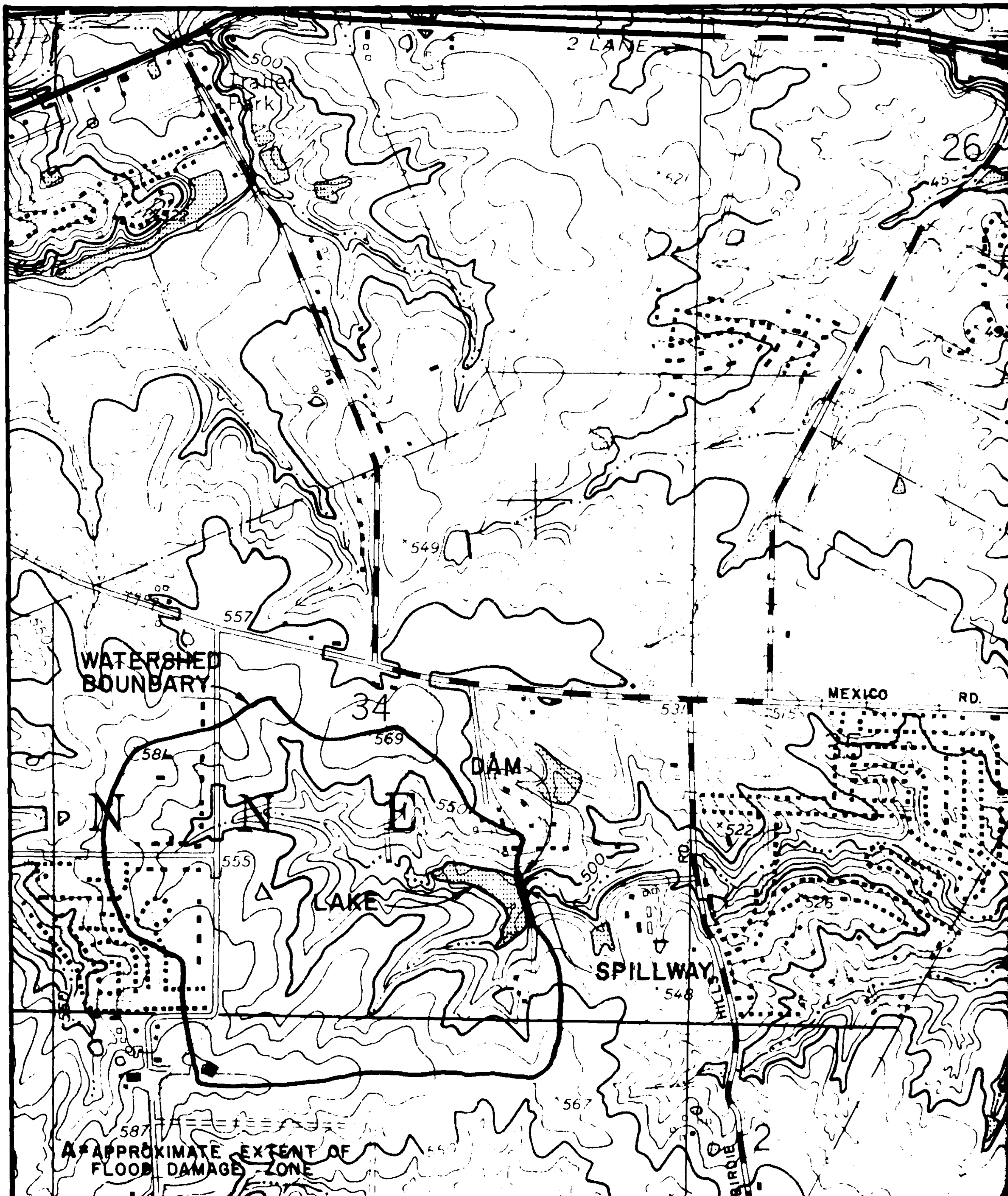
REGIONAL VICINITY MAP


OAKRIDGE
ESTATES LAKE
34
3



OAKRIDGE ESTATES
LAKE LOCATION PLAN

PLATE 2



2 LANE
Trailer Park
26
549
557
WATERSHED BOUNDARY
34
569
MEXICO RD.
DAM
N
N
E
550
522
555
500
LAKE
526
SPILLWAY
548
HILLS RD.
567
587
2
BIRDIE
A=APPROXIMATE EXTENT OF FLOOD DAMAGE ZONE

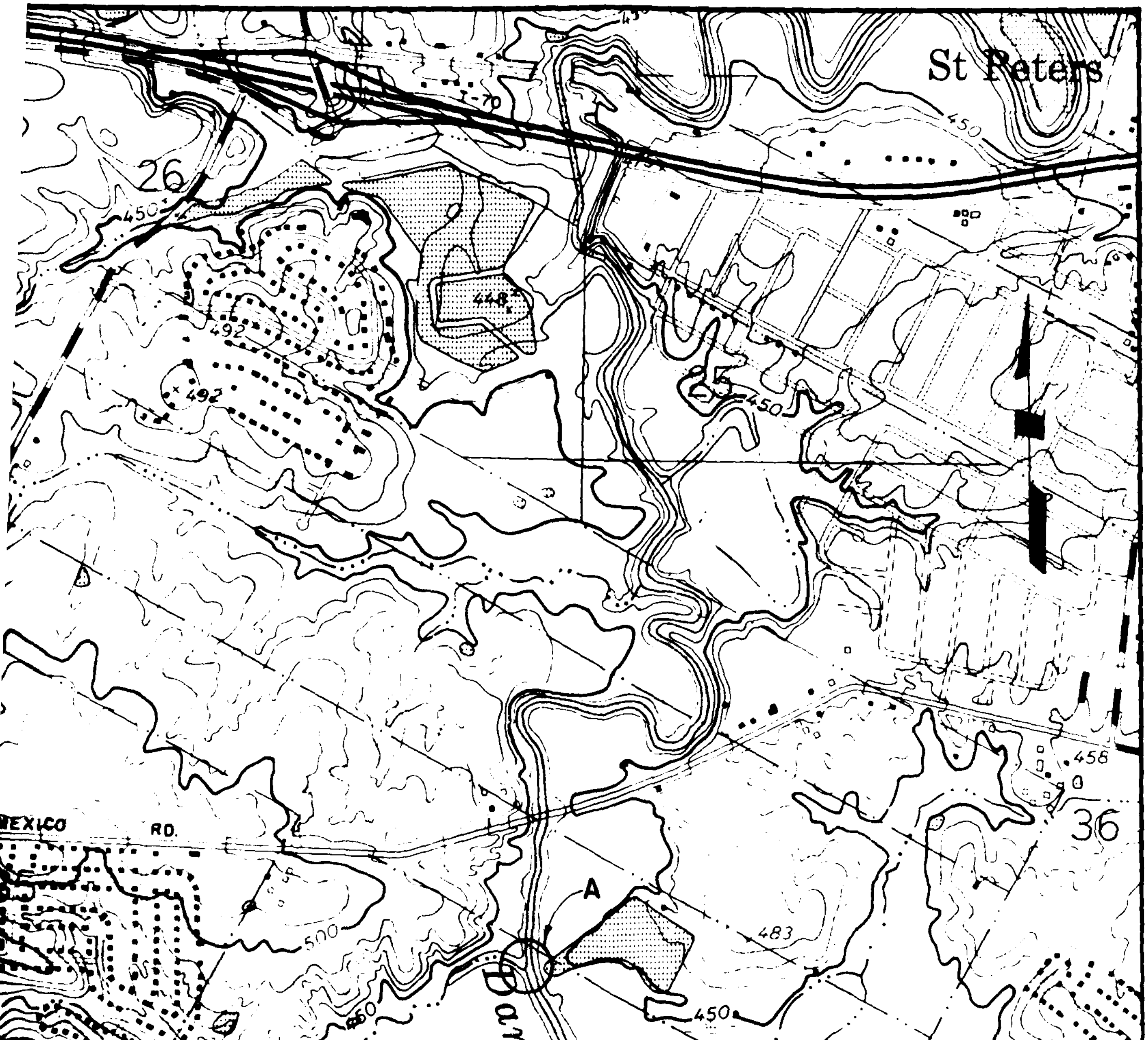
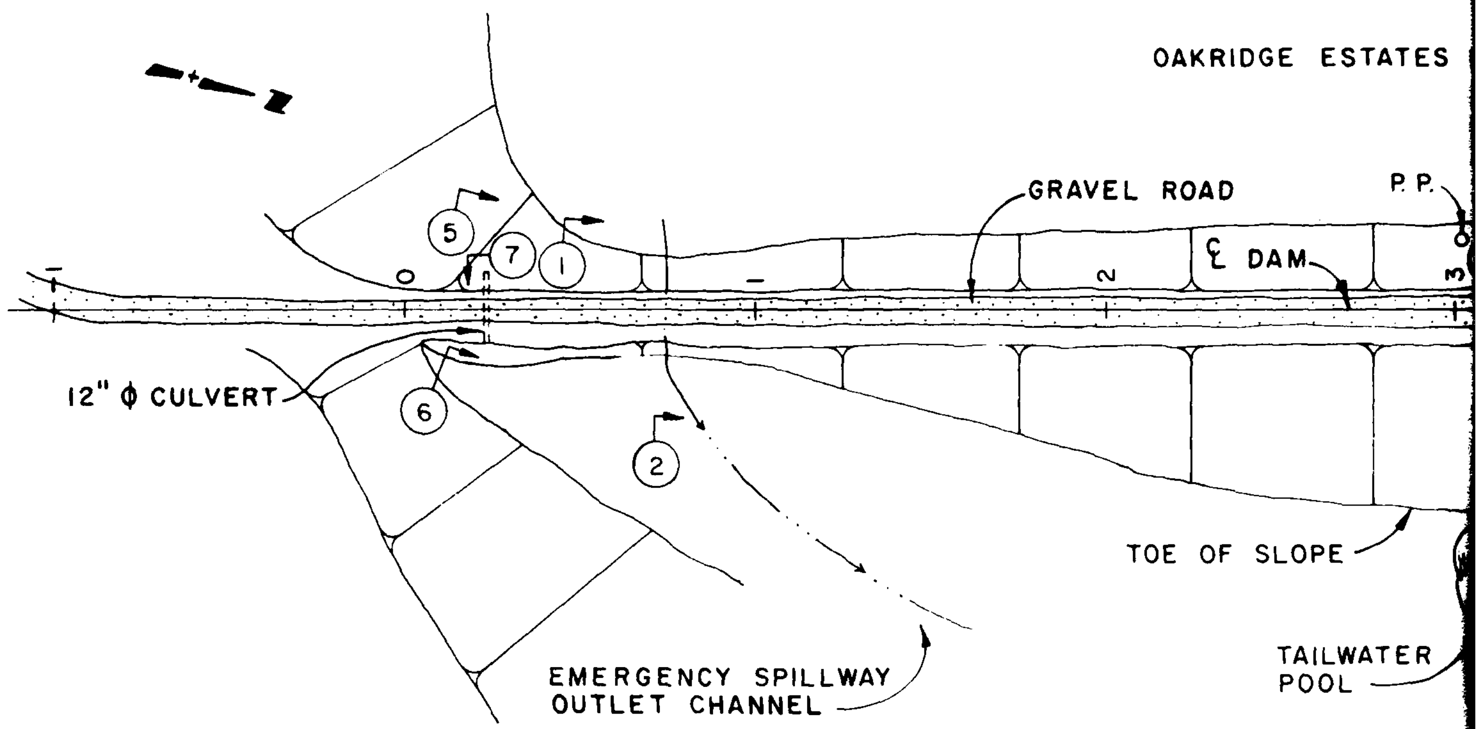
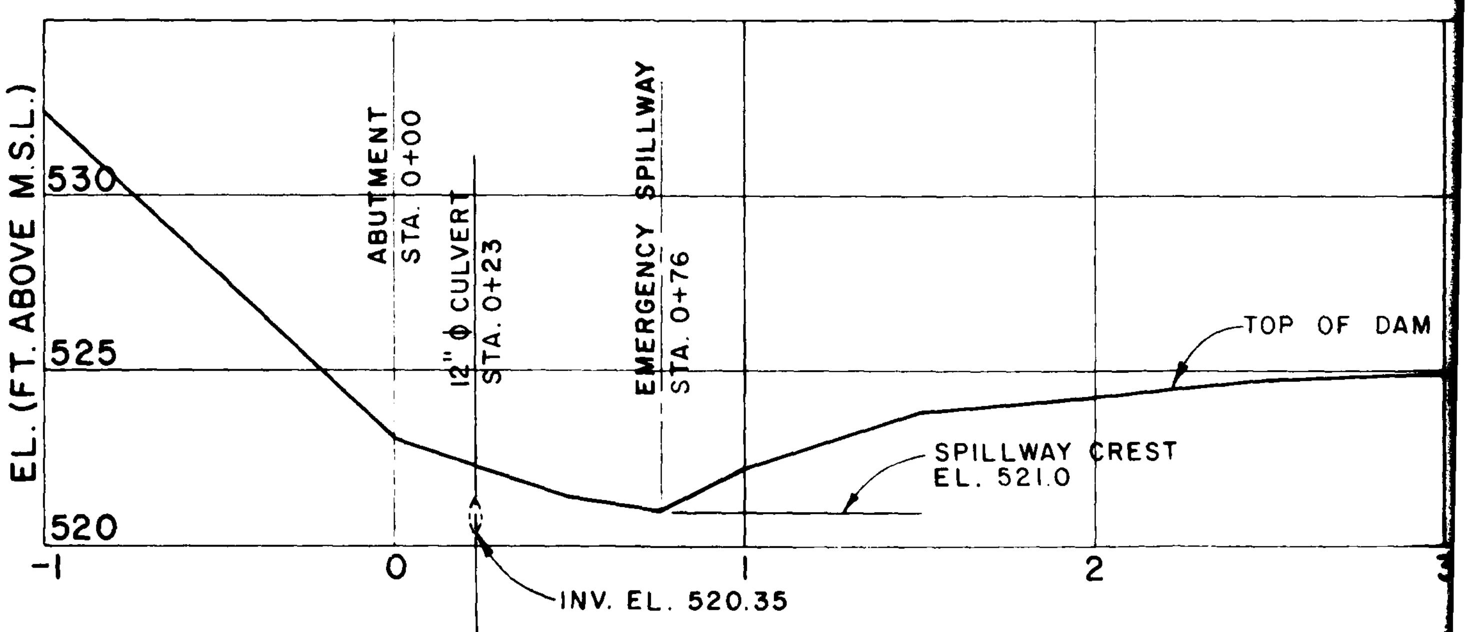

St Peters
I-70
26
450
448
492
492
36
456
MEXICO
RD.
A
483
500
450
484
454
472
Dardenne Creek
OAKRIDGE ESTATES LAKE
0
1000
3000
SCALE IN FEET
(CONTOUR INTERVAL 10 FEET)
LAKE WATERSHED MAP

PLATE 3



GENERAL PLAN OF D

SCALE: 1"=50'

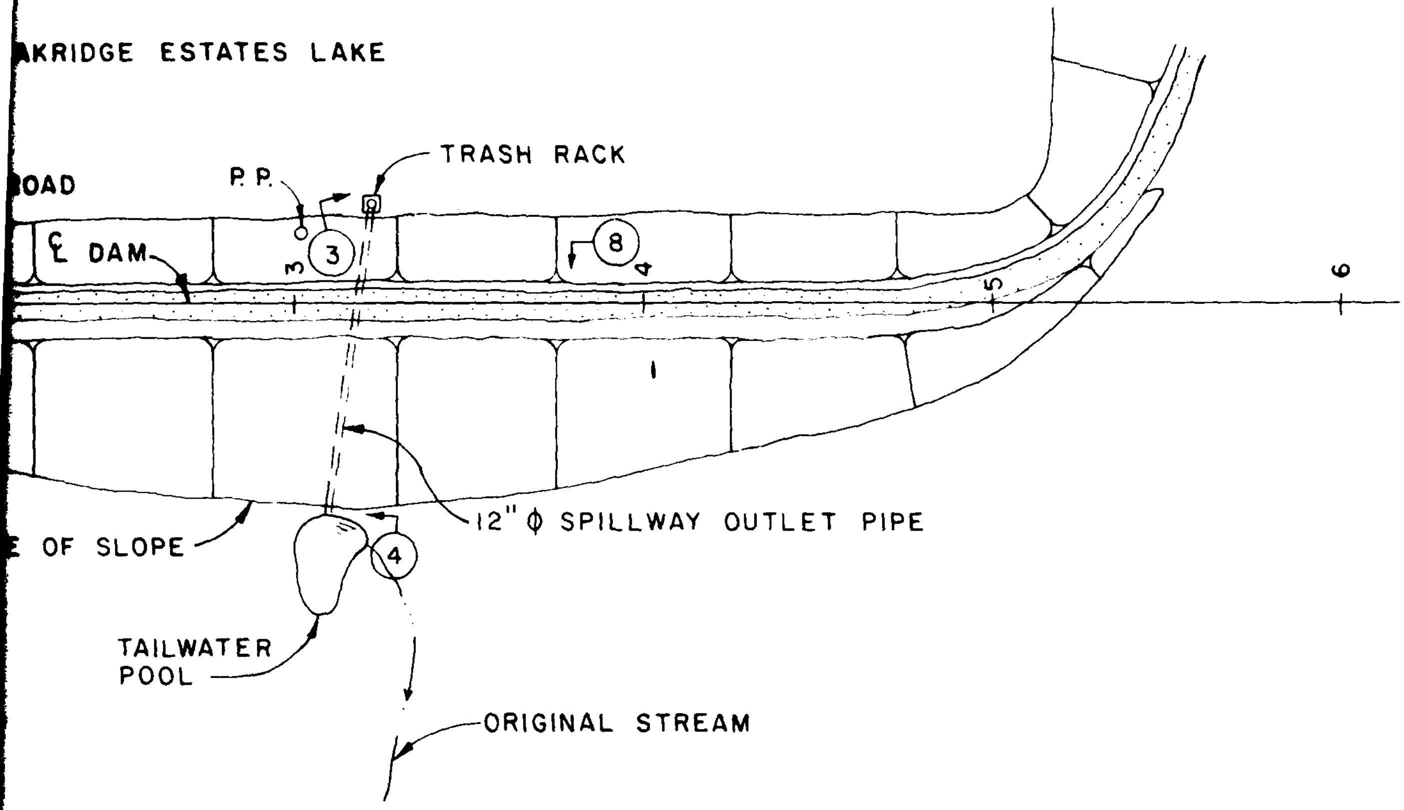


PROFILE DAM CRES

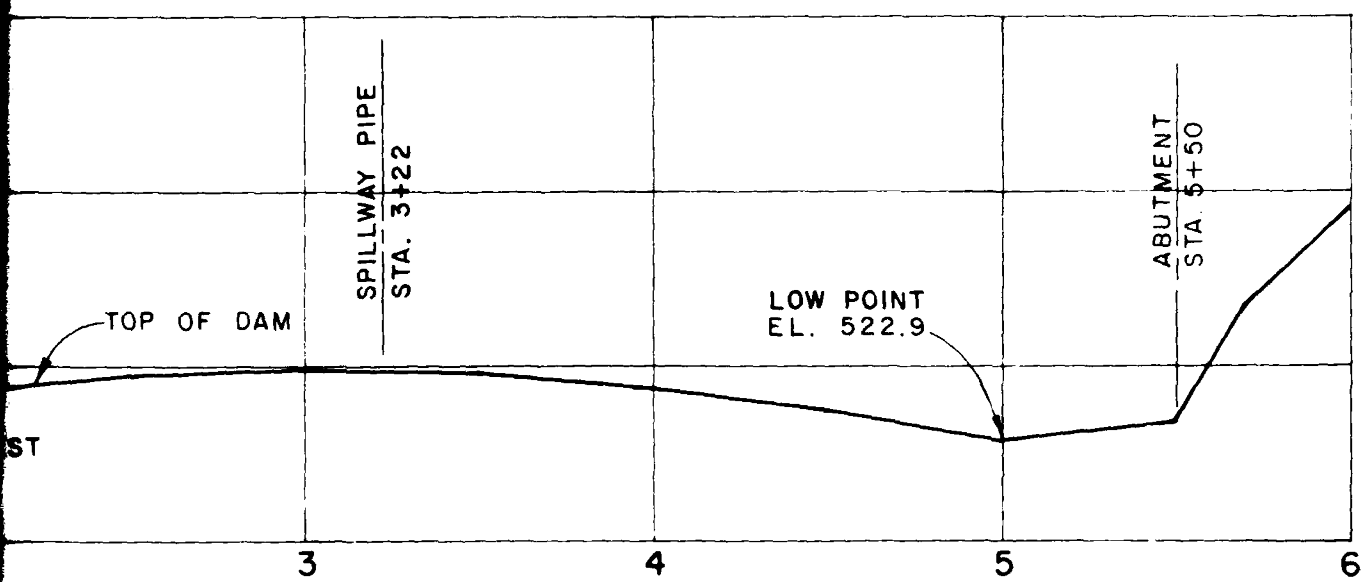
SCALE: 1"=5' V., 1"=50' H.

6

PHOTO LOCATION & KEY
(SEE APPENDIX A)



AL PLAN OF DAM
SCALE: 1"=50'

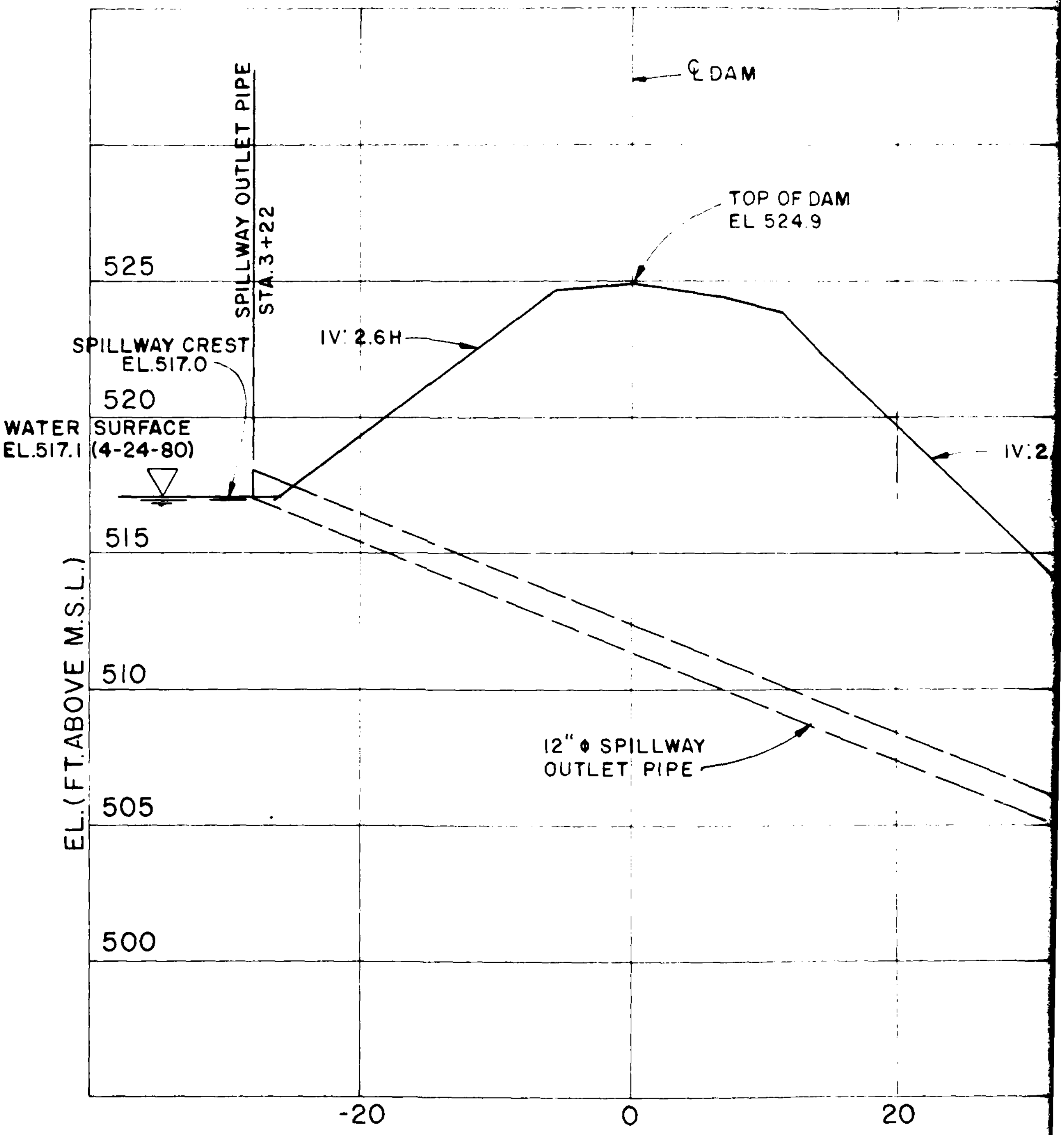


FILE DAM CREST
ALE: 1"=5' V., 1"=50' H.

OAKRIDGE ESTATES LAKE
DAM PLAN & PROFILE

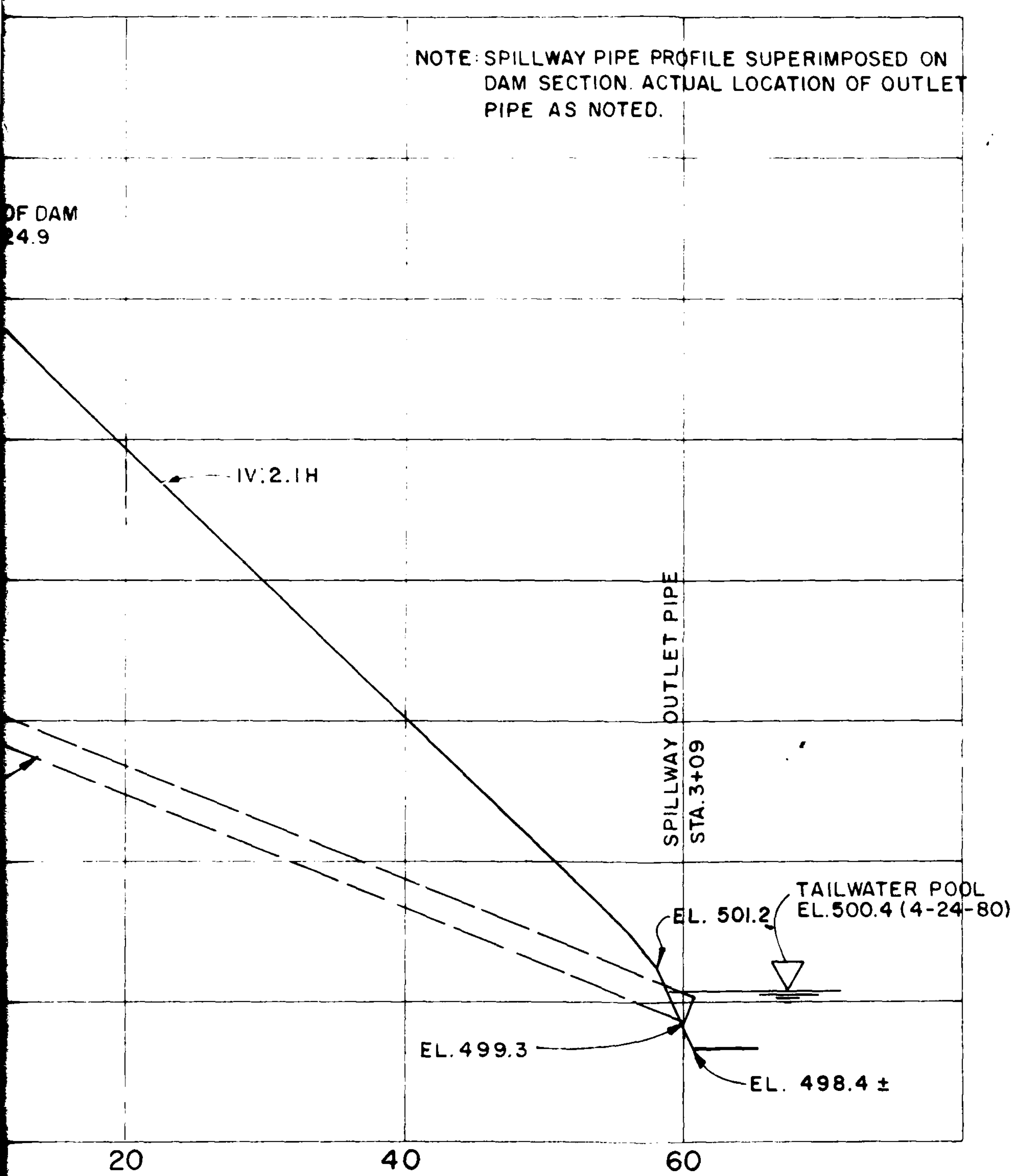
Horner & Shifrin, Inc. May 1980

PLATE 4



DAM CROSS-SECTION STA.

SCALE: 1"=5'V., 1"=10'H.



SS-SECTION STA. 3+09

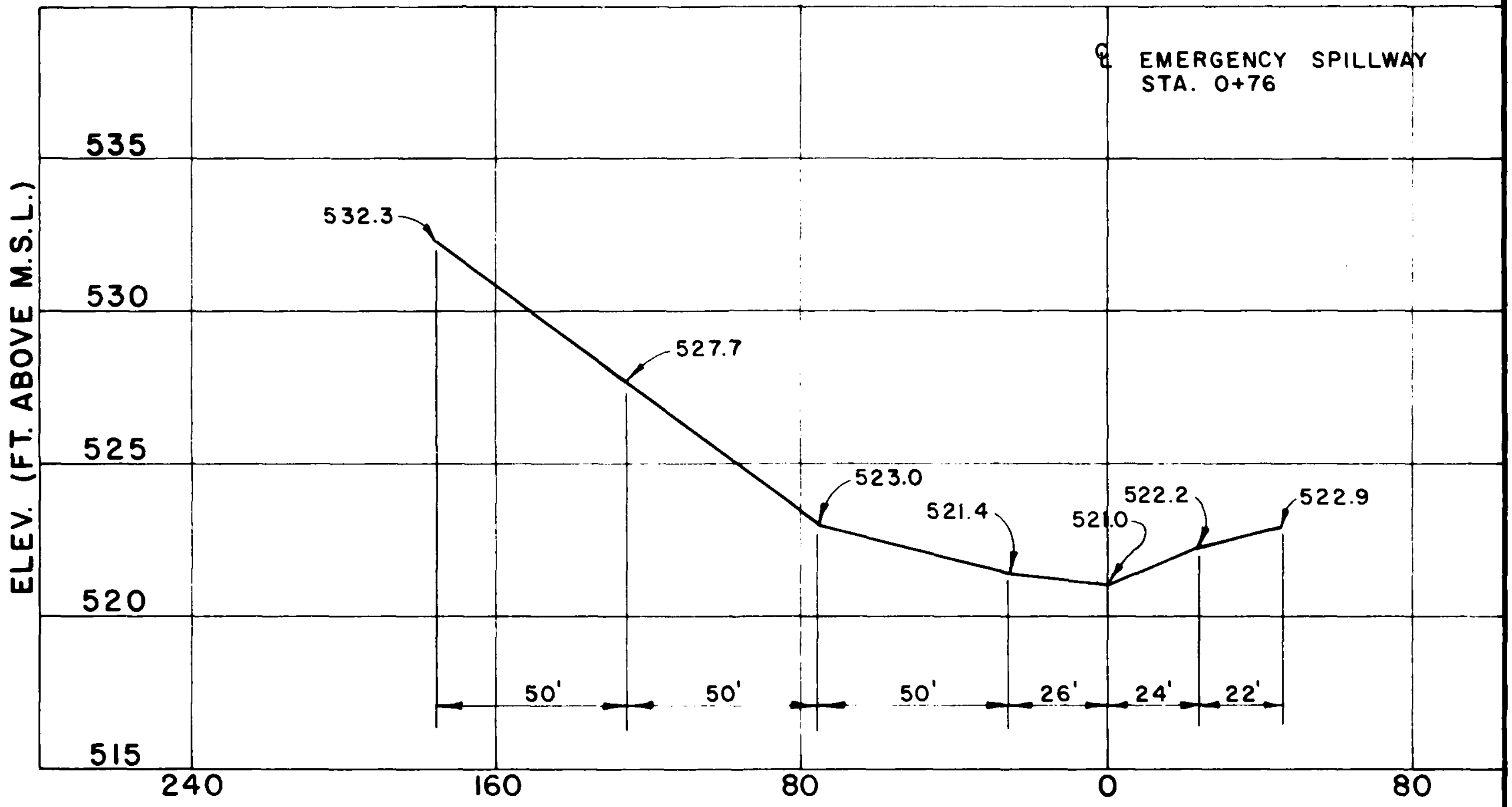
ALE: 1"=5'V., 1"=10'H.

OAKRIDGE ESTATES LAKE
DAM CROSS-SECTION

Horner & Shifrin, Inc. May 1980

PLATE 5

1 2



CROSS-SECTION AT CREST

SCALES: 1" = 5' V., 1" = 40' H.

OAKRIDGE ESTATES LAKE
EMERGENCY SPILLWAY
CROSS-SECTION

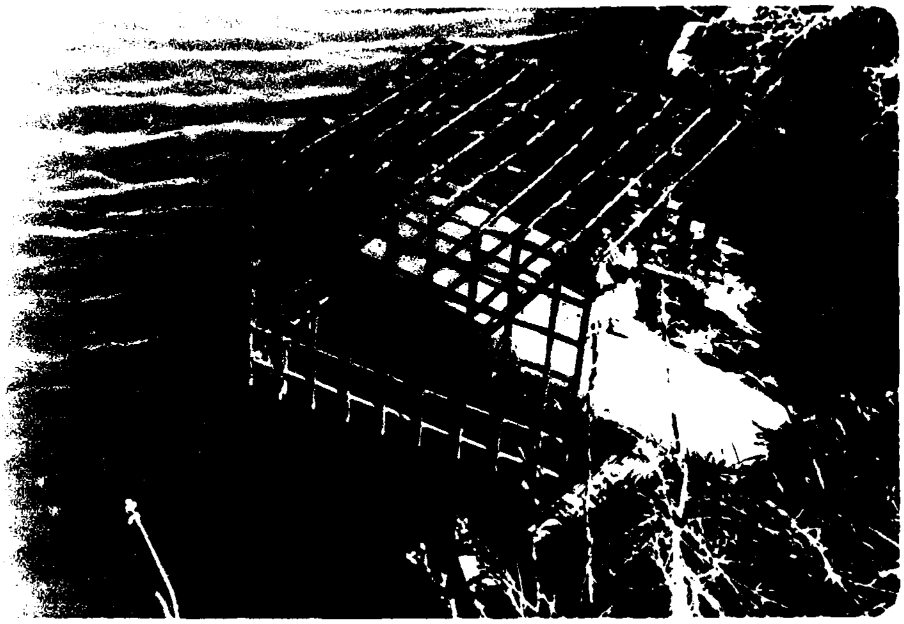
Horner & Shifrin, Inc. August 1980

APPENDIX A

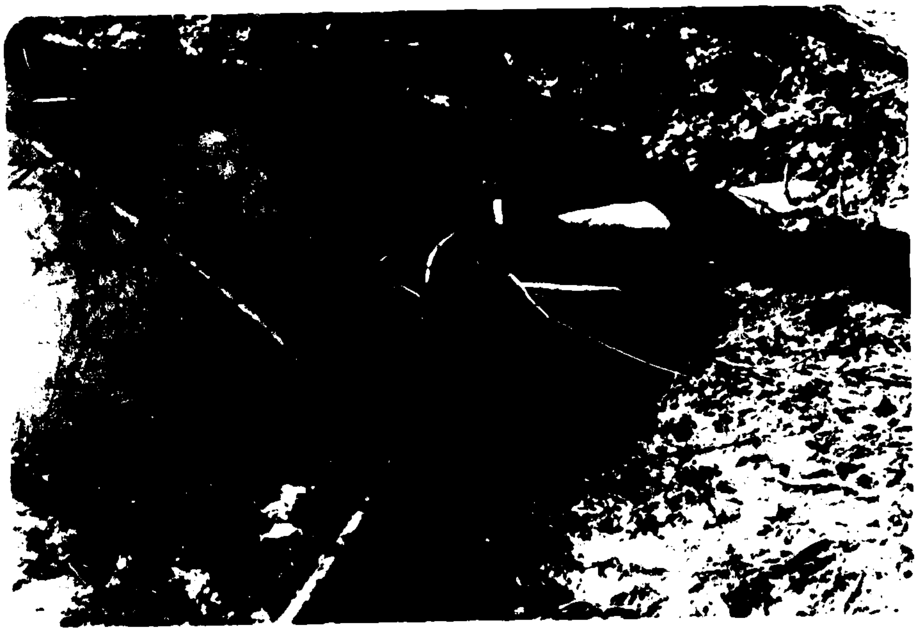
INSPECTION PHOTOGRAPHS

NO. 1: UPSTREAM FACE OF DAM

NO. 2: DOWNSTREAM FACE OF DAM



NO. 3: UPSTREAM END OF SPILLWAY PIPE



NO. 4: DOWNSTREAM END OF SPILLWAY PIPE

NO. 5: CREST OF EMERGENCY SPILLWAY

NO. 6: EMERGENCY SPILLWAY OUTLET CHANNEL

NO. 7: UPSTREAM END OF CULVERT PIPE AT EMERGENCY SPILLWAY

NO. 8: ANIMAL BURROW IN UPSTREAM FACE OF DAM

APPENDIX B

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

1. The HEC-1 Dam Safety Version (July 1978, Modified 26 February 1979) program was used to develop inflow and outflow hydrographs and dam overtopping analyses, with hydrologic inputs as follows:

a. Probable maximum precipitation (200 sq. mile, 24-hour value equals 25.1 inches) from Hydrometeorological Report No. 33. The precipitation data used in the analysis of the 1 percent chance (100-year freguency) flood was provided by the St. Louis District, Corps of Engineers. Due to the fact that the watershed for this reservoir is small, the lake level was assumed to be at normal pool as a result of antecedent storms prior to occurrence of the PMF and the probabilistic storm.

b. Drainage area = 0.330 square miles = 211 acres.

c. SCS parameters:

Time of Concentration $(T_c) = \left(\frac{11.9L^3}{H}\right)^{0.385}$

Where: T_c = Travel time of water from hydraulically most distant point of interest, hours.

L = Length of longest watercourse = 0.70 miles

H = Elevation difference = 53 feet

The time of concentration (Tc) was obtained using Method C as described in Figure 30, "Design of Small Dams", by the United States Department of the Interior, Bureau of Reclamation, and was verified using average channel velocity estimates and watercourse lengths.

Lag time = 0.224 hours (0.60 Tc)

Hydrologic Soil Group = B (100% Harvester Series soils per SCS County Soil Report)

Soil type CN = 80 (AMC II, 100-yr flood condition)
= 91 (AMC III, PMF condition)

2. Inflow to the 12-inch steel spillway pipe was determined by assuming flow was over a sharp edge submerged orifice. The following equation was used: $Q = Ca\ (2gh)^{0.5}$, where "C" is a coefficient assumed to be 0.75, "a" is the area of the orifice, 0.785 sf, "h" is the height of flow above the orifice, and "g" is acceleration due to gravity. Reference, "Handbook of Hydraulics", Fifth Edition, by King and Brater, page 4-3.

Flow through the 12-inch diameter spillway pipe was determined using Bernoulli's equation for pressure flow in pipes. Losses, including throat, entrance, pipe and exit losses totaled 4.25 velocity heads. Reference, "Handbook of Hydraulics", Fifth Edition, by King and Brater, pages 8-5 and 8-6.

Discharge quantities, determined by the methods described herein were plotted versus corresponding lake water surface elevations to determine the discharge rating curve for the spillway pipe.

3. The emergency spillway section consists of a broad-crested, V-shaped section for which conventional weir formulas do not apply.

Spillway release rates were determined as follows:

a. Spillway crest section properties (areas, "a", and top width, "t") were computed for various depths, "d".

b. It was assumed that flow over the spillway crest would occur at critical depth. Flow at critical depth Q_c was computed as

$Q_c = \left(\frac{a^3 g}{t}\right)^{0.5}$ for the various depths, "d". Corresponding velocities (v_c) and velocity heads (H_{vc}) were determined using conventional formulas.* Reference, "Handbook of Hydraulics", Fifth Edition, by King and Brater, page 8-7.

c. Static lake levels corresponding to the various values passing the spillway were computed as critical depths plus critical velocity heads ($d_c + H_{vc}$), and the relationship between lake level and spillway discharge was thus obtained. The procedure neglects the minor insignificant friction losses across the length of the spillway.

4. Flow through the 12-inch corrugated metal pipe culvert located near the emergency spillway was computed using Bernoulli's equation for pressure flow in pipes. Losses, including throat, entrance, pipe and exit losses totaled 2.83 velocity heads.

5. The discharges for the principal and emergency spillways (including the 12-inch pipe culvert) were summated for equal elevations and entered on the Y4 and Y5 cards.

6. The profile of the dam crest is irregular and flow over the dam cannot be determined by application of conventional weir formulas. Crest length and elevation data for the dam crest proper were entered into the HEC-1 Program on the $L and $V cards. The HEC-1 Program assumes that flow over the dam crest section occurs at critical depth and computes internally the flow over the dam crest and adds this flow to the flow passing the spillways as entered on the Y4 and Y5 cards.

* $v_c = \frac{Qc}{a}$; $Hvc = \frac{v^2}{2g}$

```
A1      ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2      HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF OAKRIDGE ESTATES LAKE DAM
A3      RATIOS OF PMF ROUTED THROUGH RESERVOIR
B      288       0       5       0       0       0       0       0       0       0
B1       5
J        1       4       1
J1    0.25    0.26    0.50    1.00
K        0  INFLOW                                       1
K1      INFLOW HYDROGRAPH
M        1       2   0.330                     1.0                       1


P        0    25.1     102     120     130
T                                                       -1     -91
W2           0.224
X     -1.0    -.10     2.0
K        1     DAM                                       1
K1      RESERVOIR ROUTING BY MODIFIED PULS
Y                                1       1
Y1       1                                           33.43      -1
Y4   517.0   518.0   519.0   520.3   521.0   521.5   522.0   522.5   523.0   523.5
Y4   524.3   525.0   525.7   526.4   527.1   527.8   528.5
Y5       0     3.3     5.8     7.9    10.5    29.2   106.2   248.7   463.1   780.5
Y5    1362    2057    2853    3750    4743    5828    7007
$A       0     5.9    15.1    30.8    48.9
$E     500     517     520     530     540
$$   517.0
$D   522.9
$L       0      97     137     324     361     437     448     478
$V   522.9   523.4   523.8   524.7   524.8   524.9   526.7   529.5
K       99
```

```
1A1       ANALYSIS OF DAM OVERTOPPING USING 100-YR FLOOD
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF OAKRIDGE ESTATES LAKE DAM
A3       100-YR FLOOD ROUTED THROUGH RESERVOIR
B     288       0       5                                                 4
B1      5
J       1       1       1
J1   1.00
K       0   INFLOW                                         1
K1         INFLOW HYDROGRAPH
M       0       2   0.330                     1.0                         1
O     288   6.974
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .012    .012    .012    .012    .012    .012    .012    .012
01   .012    .012    .012    .012    .012    .012    .012    .012    .012    .012
01   .012    .012    .012    .012    .012    .012    .012    .012    .012    .012
01   .012    .012    .012    .012    .012    .012    .012    .012    .023    .023
01   .023    .023    .023    .023    .023    .023    .023    .023    .023    .023
01   .023    .023    .023    .023    .023    .023    .030    .030    .030    .030
01   .030    .030    .048    .048    .048    .049    .049    .049    .134    .134
01   .134    .255    .255    .546    .817    .380    .255    .134    .134    .134
01   .049    .049    .049    .048    .048    .048    .030    .030    .030    .030
01   .030    .030    .023    .023    .023    .023    .023    .023    .023    .023
01   .023    .023    .023    .023    .023    .023    .023    .023    .023    .023
01   .012    .012    .012    .012    .012    .012    .012    .012    .012    .012
01   .012    .012    .012    .012    .012    .012    .012    .012    .012    .012
01   .012    .012    .012    .012    .012    .012    .012    .012    .012    .012
01   .012    .012    .012    .012    .012    .012    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .077    .007    .007    .007
T                                                    -1     -80
W2          0.224
X    -1.0    -.10     2.0
K       1     DAM                                      1
```

100-YR. FLOOD (cont'd)

K1	RESERVOIR ROUTING BY MODIFIED PULS									
Y				1	1					
Y1	1						33.43	-1		
Y4	517.0	518.0	519.0	520.3	521.0	521.5	522.0	522.5	523.0	523.5
Y4	524.3	525.0	525.7	526.4	527.1	527.8	528.5			
Y5	0	3.3	5.8	7.9	10.5	29.2	106.2	248.7	463.1	780.5
Y5	1362	2057	2853	3750	4743	5828	7007			
$A	0	5.9	15.1	30.8	48.9					
$E	500	517	520	530	540					
$$	517.0									
$D	522.9									
$L	0	97	137	324	361	437	448	478		
$V	522.9	523.4	523.8	524.7	524.8	524.9	526.7	529.5		
K	99									

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF OAKRIDGE ESTATES LAKE DAM
RATIOS OF PMF ROUTED THROUGH RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1
RTIOS= .25 .26 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
INFLOW	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.33	0.00	.33	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.10	102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-91.00	0.00	0.00

CURVE NO = -91.00 WETNESS = -1.00 EFFECT CN = 91.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .22

RECESSION DATA
STRTQ= -1.00 QRCSN= -.10 RTIOR= 2.00

UNIT HYDROGRAPH 15 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .22 VOL= 1.00

124.	423.	597.	536.	359.	205.	125.	75.	45.	27.
16.	10.	6.	4.	2.					

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.05	145	.21	.21	.01	174.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.21	.21	.00	237.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	.21	.21	.00	325.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.21	.21	.00	404.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.25	149	.21	.21	.00	457.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	.21	.21	.00	488.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	.21	.21	.00	507.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.21	.21	.00	519.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.21	.21	.00	526.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.21	.21	.00	530.
1.01	.55	11	.01	0.00	.01	0.	1.01	12.55	155	.21	.21	.00	533.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.00	156	.21	.21	.00	535.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.05	157	.26	.25	.00	542.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.10	158	.26	.25	.00	560.
1.01	1.15	15	.01	.00	.01	0.	1.01	13.15	159	.26	.25	.00	586.
1.01	1.20	16	.01	.00	.01	0.	1.01	13.20	160	.26	.25	.00	609.
1.01	1.25	17	.01	.00	.01	0.	1.01	13.25	161	.26	.25	.00	625.
1.01	1.30	18	.01	.00	.01	1.	1.01	13.30	162	.26	.25	.00	634.
1.01	1.35	19	.01	.00	.01	2.	1.01	13.35	163	.26	.25	.00	639.
1.01	1.40	20	.01	.00	.01	2.	1.01	13.40	164	.26	.25	.00	643.
1.01	1.45	21	.01	.00	.01	3.	1.01	13.45	165	.26	.25	.00	645.
1.01	1.50	22	.01	.00	.01	4.	1.01	13.50	166	.26	.25	.00	647.
1.01	1.55	23	.01	.00	.01	5.	1.01	13.55	167	.26	.25	.00	647.
1.01	2.00	24	.01	.00	.01	6.	1.01	14.00	168	.26	.25	.00	648.
1.01	2.05	25	.01	.00	.01	6.	1.01	14.05	169	.32	.32	.00	657.
1.01	2.10	26	.01	.00	.01	7.	1.01	14.10	170	.32	.32	.00	684.
1.01	2.15	27	.01	.00	.01	8.	1.01	14.15	171	.32	.32	.00	722.
1.01	2.20	28	.01	.00	.01	8.	1.01	14.20	172	.32	.32	.00	756.
1.01	2.25	29	.01	.00	.01	9.	1.01	14.25	173	.32	.32	.00	779.
1.01	2.30	30	.01	.00	.01	10.	1.01	14.30	174	.32	.32	.00	793.
1.01	2.35	31	.01	.00	.01	10.	1.01	14.35	175	.32	.32	.00	801.
1.01	2.40	32	.01	.00	.01	11.	1.01	14.40	176	.32	.32	.00	806.
1.01	2.45	33	.01	.01	.01	11.	1.01	14.45	177	.32	.32	.00	809.
1.01	2.50	34	.01	.01	.01	12.	1.01	14.50	178	.32	.32	.00	811.
1.01	2.55	35	.01	.01	.01	13.	1.01	14.55	179	.32	.32	.00	812.
1.01	3.00	36	.01	.01	.01	13.	1.01	15.00	180	.32	.32	.00	813.
1.01	3.05	37	.01	.01	.01	14.	1.01	15.05	181	.19	.19	.00	798.
1.01	3.10	38	.01	.01	.01	14.	1.01	15.10	182	.39	.39	.00	770.
1.01	3.15	39	.01	.01	.01	14.	1.01	15.15	183	.39	.39	.00	777.
1.01	3.20	40	.01	.01	.01	15.	1.01	15.20	184	.58	.58	.00	850.
1.01	3.25	41	.01	.01	.01	15.	1.01	15.25	185	.68	.68	.00	1003.
1.01	3.30	42	.01	.01	.01	16.	1.01	15.30	186	1.65	1.65	.00	1325.
1.01	3.35	43	.01	.01	.01	16.	1.01	15.35	187	2.72	2.72	.01	2054.
1.01	3.40	44	.01	.01	.01	17.	1.01	15.40	188	1.07	1.07	.00	3018.
1.01	3.45	45	.01	.01	.01	17.	1.01	15.45	189	.68	.68	.00	3514.
1.01	3.50	46	.01	.01	.01	17.	1.01	15.50	190	.58	.58	.00	3323.
1.01	3.55	47	.01	.01	.01	18.	1.01	15.55	191	.39	.39	.00	2754.

PMF END-OF-PERIOD FLOW (cont'd)

1.01	4.00	48	.01	.01	.01	18.
1.01	4.05	49	.01	.01	.01	18.
1.01	4.10	50	.01	.01	.01	19.
1.01	4.15	51	.01	.01	.01	19.
1.01	4.20	52	.01	.01	.01	19.
1.01	4.25	53	.01	.01	.01	20.
1.01	4.30	54	.01	.01	.01	20.
1.01	4.35	55	.01	.01	.01	20.
1.01	4.40	56	.01	.01	.01	21.
1.01	4.45	57	.01	.01	.01	21.
1.01	4.50	58	.01	.01	.01	21.
1.01	4.55	59	.01	.01	.01	21.
1.01	5.00	60	.01	.01	.01	22.
1.01	5.05	61	.01	.01	.01	22.
1.01	5.10	62	.01	.01	.01	22.
1.01	5.15	63	.01	.01	.00	22.
1.01	5.20	64	.01	.01	.00	23.
1.01	5.25	65	.01	.01	.00	23.
1.01	5.30	66	.01	.01	.00	23.
1.01	5.35	67	.01	.01	.00	23.
1.01	5.40	68	.01	.01	.00	23.
1.01	5.45	69	.01	.01	.00	24.
1.01	5.50	70	.01	.01	.00	24.
1.01	5.55	71	.01	.01	.00	24.
1.01	6.00	72	.01	.01	.00	24.
1.01	6.05	73	.06	.04	.02	29.
1.01	6.10	74	.06	.05	.02	44.
1.01	6.15	75	.06	.05	.02	65.
1.01	6.20	76	.06	.05	.02	85.
1.01	6.25	77	.06	.05	.01	99.
1.01	6.30	78	.06	.05	.01	109.
1.01	6.35	79	.06	.05	.01	115.
1.01	6.40	80	.06	.05	.01	120.
1.01	6.45	81	.06	.05	.01	123.
1.01	6.50	82	.06	.05	.01	126.
1.01	6.55	83	.06	.05	.01	128.
1.01	7.00	84	.06	.05	.01	130.
1.01	7.05	85	.06	.05	.01	132.
1.01	7.10	86	.06	.05	.01	134.
1.01	7.15	87	.06	.05	.01	135.
1.01	7.20	88	.06	.05	.01	136.
1.01	7.25	89	.06	.05	.01	137.
1.01	7.30	90	.06	.05	.01	139.
1.01	7.35	91	.06	.06	.01	140.
1.01	7.40	92	.06	.06	.01	140.
1.01	7.45	93	.06	.06	.01	141.
1.01	7.50	94	.06	.06	.01	142.
1.01	7.55	95	.06	.06	.01	143.
1.01	8.00	96	.06	.06	.01	144.
1.01	8.05	97	.06	.06	.01	144.
1.01	8.10	98	.06	.06	.01	145.
1.01	8.15	99	.06	.06	.01	145.
1.01	8.20	100	.06	.06	.00	146.
1.01	8.25	101	.06	.06	.00	147.
1.01	16.00	192	.39	.39	.00	2172.
1.01	16.05	193	.30	.30	.00	1733.
1.01	16.10	194	.30	.30	.00	1399.
1.01	16.15	195	.30	.30	.00	1161.
1.01	16.20	196	.30	.30	.00	1004.
1.01	16.25	197	.30	.30	.00	907.
1.01	16.30	198	.30	.30	.00	849.
1.01	16.35	199	.30	.30	.00	814.
1.01	16.40	200	.30	.30	.00	793.
1.01	16.45	201	.30	.30	.00	778.
1.01	16.50	202	.30	.30	.00	769.
1.01	16.55	203	.30	.30	.00	765.
1.01	17.00	204	.30	.30	.00	763.
1.01	17.05	205	.23	.23	.00	755.
1.01	17.10	206	.23	.23	.00	727.
1.01	17.15	207	.23	.23	.00	689.
1.01	17.20	208	.23	.23	.00	655.
1.01	17.25	209	.23	.23	.00	632.
1.01	17.30	210	.23	.23	.00	619.
1.01	17.35	211	.23	.23	.00	611.
1.01	17.40	212	.23	.23	.00	606.
1.01	17.45	213	.23	.23	.00	603.
1.01	17.50	214	.23	.23	.00	601.
1.01	17.55	215	.23	.23	.00	600.
1.01	18.00	216	.23	.23	.00	600.
1.01	18.05	217	.02	.02	.00	573.
1.01	18.10	218	.02	.02	.00	482.
1.01	18.15	219	.02	.02	.00	354.
1.01	18.20	220	.02	.02	.00	328.
1.01	18.25	221	.02	.02	.00	306.
1.01	18.30	222	.02	.02	.00	286.
1.01	18.35	223	.02	.02	.00	267.
1.01	18.40	224	.02	.02	.00	249.
1.01	18.45	225	.02	.02	.00	232.
1.01	18.50	226	.02	.02	.00	217.
1.01	18.55	227	.02	.02	.00	202.
1.01	19.00	228	.02	.02	.00	189.
1.01	19.05	229	.02	.02	.00	176.
1.01	19.10	230	.02	.02	.00	164.
1.01	19.15	231	.02	.02	.00	153.
1.01	19.20	232	.02	.02	.00	143.
1.01	19.25	233	.02	.02	.00	133.
1.01	19.30	234	.02	.02	.00	124.
1.01	19.35	235	.02	.02	.00	116.
1.01	19.40	236	.02	.02	.00	108.
1.01	19.45	237	.02	.02	.00	101.
1.01	19.50	238	.02	.02	.00	94.
1.01	19.55	239	.02	.02	.00	88.
1.01	20.00	240	.02	.02	.00	82.
1.01	20.05	241	.02	.02	.00	77.
1.01	20.10	242	.02	.02	.00	71.
1.01	20.15	243	.02	.02	.00	67.
1.01	20.20	244	.02	.02	.00	62.
1.01	20.25	245	.02	.02	.00	58.

PMF END-OF-PERIOD FLOW (cont'd)

1.01	8.30	102	.06	.06	.00	147.	1.01	20.30	246	.02	.02	.00	54.
1.01	8.35	103	.06	.06	.00	148.	1.01	20.35	247	.02	.02	.00	53.
1.01	8.40	104	.06	.06	.00	148.	1.01	20.40	248	.02	.02	.00	53.
1.01	8.45	105	.06	.06	.00	148.	1.01	20.45	249	.02	.02	.00	53.
1.01	8.50	106	.06	.06	.00	149.	1.01	20.50	250	.02	.02	.00	53.
1.01	8.55	107	.06	.06	.00	149.	1.01	20.55	251	.02	.02	.00	53.
1.01	9.00	108	.06	.06	.00	150.	1.01	21.00	252	.02	.02	.00	53.
1.01	9.05	109	.06	.06	.00	150.	1.01	21.05	253	.02	.02	.00	53.
1.01	9.10	110	.06	.06	.00	150.	1.01	21.10	254	.02	.02	.00	53.
1.01	9.15	111	.06	.06	.00	151.	1.01	21.15	255	.02	.02	.00	53.
1.01	9.20	112	.06	.06	.00	151.	1.01	21.20	256	.02	.02	.00	53.
1.01	9.25	113	.06	.06	.00	151.	1.01	21.25	257	.02	.02	.00	53.
1.01	9.30	114	.06	.06	.00	151.	1.01	21.30	258	.02	.02	.00	53.
1.01	9.35	115	.06	.06	.00	152.	1.01	21.35	259	.02	.02	.00	53.
1.01	9.40	116	.06	.06	.00	152.	1.01	21.40	260	.02	.02	.00	53.
1.01	9.45	117	.06	.06	.00	152.	1.01	21.45	261	.02	.02	.00	53.
1.01	9.50	118	.06	.06	.00	152.	1.01	21.50	262	.02	.02	.00	53.
1.01	9.55	119	.06	.06	.00	153.	1.01	21.55	263	.02	.02	.00	53.
1.01	10.00	120	.06	.06	.00	153.	1.01	22.00	264	.02	.02	.00	53.
1.01	10.05	121	.06	.06	.00	153.	1.01	22.05	265	.02	.02	.00	53.
1.01	10.10	122	.06	.06	.00	153.	1.01	22.10	266	.02	.02	.00	53.
1.01	10.15	123	.06	.06	.00	153.	1.01	22.15	267	.02	.02	.00	53.
1.01	10.20	124	.06	.06	.00	154.	1.01	22.20	268	.02	.02	.00	53.
1.01	10.25	125	.06	.06	.00	154.	1.01	22.25	269	.02	.02	.00	53.
1.01	10.30	126	.06	.06	.00	154.	1.01	22.30	270	.02	.02	.00	53.
1.01	10.35	127	.06	.06	.00	154.	1.01	22.35	271	.02	.02	.00	53.
1.01	10.40	128	.06	.06	.00	154.	1.01	22.40	272	.02	.02	.00	53.
1.01	10.45	129	.06	.06	.00	154.	1.01	22.45	273	.02	.02	.00	53.
1.01	10.50	130	.06	.06	.00	154.	1.01	22.50	274	.02	.02	.00	53.
1.01	10.55	131	.06	.06	.00	155.	1.01	22.55	275	.02	.02	.00	53.
1.01	11.00	132	.06	.06	.00	155.	1.01	23.00	276	.02	.02	.00	53.
1.01	11.05	133	.06	.06	.00	155.	1.01	23.05	277	.02	.02	.00	53.
1.01	11.10	134	.06	.06	.00	155.	1.01	23.10	278	.02	.02	.00	53.
1.01	11.15	135	.06	.06	.00	155.	1.01	23.15	279	.02	.02	.00	53.
1.01	11.20	136	.06	.06	.00	155.	1.01	23.20	280	.02	.02	.00	53.
1.01	11.25	137	.06	.06	.00	155.	1.01	23.25	281	.02	.02	.00	53.
1.01	11.30	138	.06	.06	.00	155.	1.01	23.30	282	.02	.02	.00	53.
1.01	11.35	139	.06	.06	.00	156.	1.01	23.35	283	.02	.02	.00	53.
1.01	11.40	140	.06	.06	.00	156.	1.01	23.40	284	.02	.02	.00	53.
1.01	11.45	141	.06	.06	.00	156.	1.01	23.45	285	.02	.02	.00	53.
1.01	11.50	142	.06	.06	.00	156.	1.01	23.50	286	.02	.02	.00	53.
1.01	11.55	143	.06	.06	.00	156.	1.01	23.55	287	.02	.02	.00	53.
1.01	12.00	144	.06	.06	.00	156.	1.02	0.00	288	.02	.02	.00	53.

SUM	32.63	31.47	1.16	82459.
	(829.)	(799.)	(29.)	(2334.98)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3514.	894.	286.	286.	82452.
CMS	100.	25.	8.	8.	2335.
INCHES		25.19	32.28	32.28	32.28
MM		639.92	819.93	819.93	819.93
AC-FT		443.	568.	568.	568.
THOUS CU M		547.	700.	700.	700.

SURFACE AREA=	0.	6.	15.	31.	49.
CAPACITY=	0.	33.	64.	289.	684.
ELEVATION=	500.	517.	520.	530.	540.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL

SUMMARY OF DAM SAFETY ANALYSIS

PMF

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	517.00	517.00	522.90
STORAGE	33.	33.	113.
OUTFLOW	0.	0.	420.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	522.86	0.00	113.	402.	0.00	16.08	0.00
.26	522.94	.04	114.	437.	.25	16.08	0.00
.50	523.90	1.00	133.	1284.	1.75	15.92	0.00
1.00	524.84	1.94	153.	2991.	5.42	15.92	0.00

SUMMARY OF DAM SAFETY ANALYSIS

100-YEAR FLOOD

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	517.00	517.00	522.90
STORAGE	33.	33.	113.
OUTFLOW	0.	0.	420.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	521.62	0.00	90.	48.	0.00	15.17	0.00

DATE

FILMED